NOVA SCOTIA FARM WELL WATER QUALITY ASSURANCE STUDY

Province of Nova Scotia

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NOVA SCOTIA
FARM WELL WATER
QUALITY ASSURANCE STUDY

Phase I — Final Report

Nova Scotia Department of the Environment
Nova Scotia Department of Agriculture and Marketing
Nova Scotia Department of Health and Fitness

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EXECUTIVE SUMMARY

As part of ongoing environmental monitoring and research efforts of the Nova Scotia Government, the Departments of Environment, Agriculture and Marketing, and Health and Fitness are conducting a cooperative study of rural well water supplies in Kings County. Initiated in 1988 this project is designed to assess the quality of drinking water supplies in the intensively farmed areas of the County.

As one component of this study, 234 randomly selected wells were sampled in the summer and fall of 1989 to obtain an overview of water quality in the study area. Of these, 98 wells were tested for a range of pest control products, inorganic parameters, and bacteria and 136 wells were tested for inorganic parameters only.

The results of this survey show that nitrate levels and bacteria counts in a small number of wells exceed the limits established under the Guidelines for Canadian Drinking Water Quality, 12.4% and 7.1% respectively. Initial indications are that well depth and soil texture appear to play a significant role in determining which wells exceed the guidelines. Shallow wells in sandy soils are far more likely to have high levels of nitrate than deep wells in heavier textured soils.

Trace amounts of pesticides have also been found in some wells, however, the levels detected are well below safe drinking water limits established under the Guidelines for Canadian Drinking Water Quality and in many cases approach the lower detection limits of the analysis.

During the next two years the project will focus on determining the sources of pesticide, nitrate and bacterial contamination found, factors contributing to the movement of these contaminants into well water supplies, and management practices that can be implemented to help maintain the quality of drinking water supplies within the intensive agricultural areas of Nova Scotia.

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1 INTRODUCTION

In carrying out a coordinated effort to study the quality of well water supplies in agricultural areas of the Province, the Provincial Departments of Agriculture and Marketing, Health and Fitness, and Environment, with funding support from the Canada/Nova Scotia Agri-Food Development Agreement, have conducted a random survey of 234 rural wells in the intensive agriculture area of Kings County. In addition, as follow up to the survey, the Departments are conducting a detailed seasonal survey and case study analysis of selected contaminated wells. As a third and final component of the coordinated program the Inland Waters Directorate of Environment Canada, in cooperation with Agriculture Canada, has commenced a comprehensive field study focused on the factors influencing the migration and chemical breakdown of the pest control product Atrazine.

The combined study program has three objectives:

1. To identify occurrences and estimate the degree of farm well contamination in the intensive agricultural region of Nova Scotia.
2. To identify the most likely sources of any contaminants found, both point and non point, and the possible mechanisms and pathways by which the contaminants entered the well.
3. To provide the results in useful form to agricultural policy makers, specialists and farmers to aid them in developing new practices and policies to maintain the quality of groundwater in agricultural areas.

The purpose of this report is to present the results of the initial random survey of well water quality in the Kings County study area and to outline proposed work for the remaining two years of the project.

2 STUDY AREA

The study area for the project encompasses the watersheds of four river basins draining into the Minas Basin from the agricultural areas of Kings County:

- The Cornwallis
- The Canard
- The Habitant
- The Gaspereau

Figure 1 shows the study area. The area was further subdivided into 75 sub-basins (minor watersheds) for classification purposes.

3 SURVEY PROCEDURES

In preparation for the project staff of NSDOE classified the watersheds within the study area based on their sensitivity to groundwater contamination using a modified DRASTIC classification system (Aller et. al., 1987). DRASTIC is a classification system for groundwater sensitivity developed by the National Water Well Association (USA) and the United States Environmental Protection Agency (EPA) for use in sampling strategy design for similar types of groundwater studies.

During the same period staff of NSDAM identified the location of all farms within the study area on 1:10,000 orthophoto map sheets.

Using the DRASTIC ratings, each farm identified was assigned a risk number for classification purposes. Weighted probability list sampling (Husch, Miller and Beers, 1972) was then used to randomly select farm wells for sampling.

During the period from mid-June to mid-August, 1989, 98 randomly selected farm wells were sampled by staff from the Departments of Health and Fitness and Environment. Samples from these wells were tested for selected pesticides (see Table 1), inorganic parameters (see Table 3), and bacteria. In late August to early September this initial sampling was augmented with 136 additional randomly selected wells which were tested for inorganic parameters only.

Analyses of samples collected were carried out at three laboratories in Nova Scotia as follows:

1. Inorganic parameters (Table 3) — Agriculture and Marketing soil chemistry lab in Truro.
2. Bacteria — Health and Fitness lab at the Victoria General Hospital in Halifax.
3. Pest control products (Table 1) — Agriculture and Marketing pesticide residue lab in Kentville.

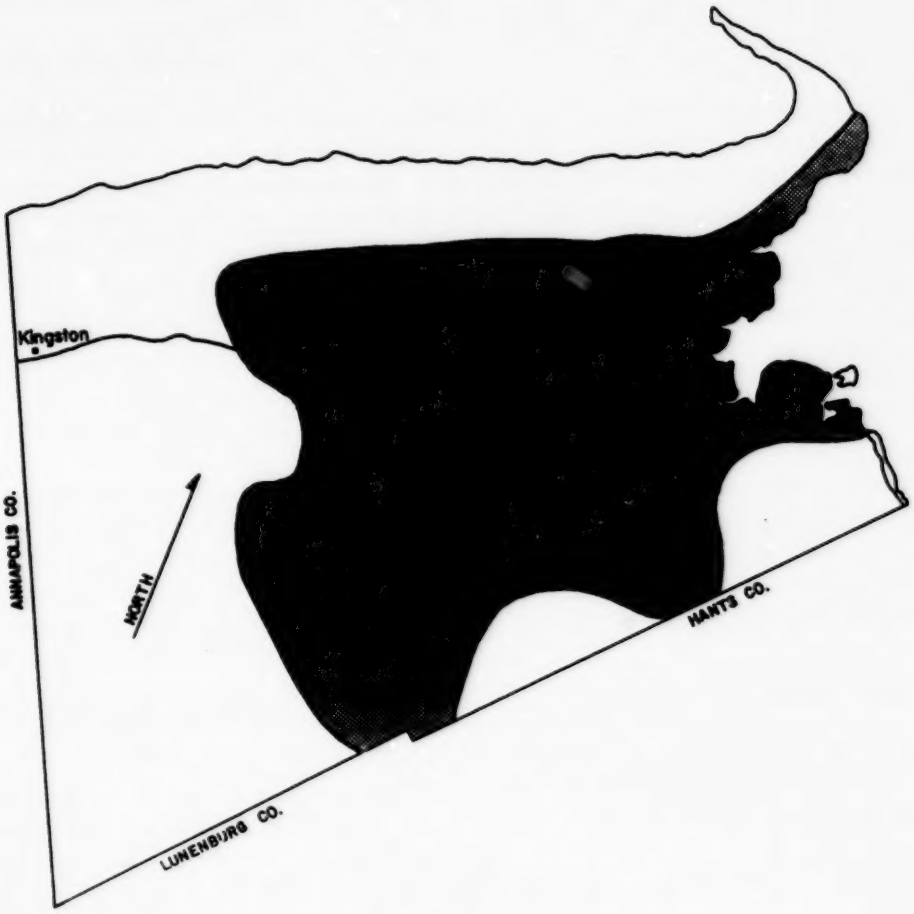

Figure 1: Study Area — N.S. Farm Well Water Quality Assurance Study

Table 1: Organic Parameters Screened For

CHEMICAL NAME *		SOME COMMON OR TRADE NAMES
ATRAZINE		AATREX, PRIMATOL, VECTAL
	WITH CYANAZINE	BLAZINE
	WITH BENTAZON	LADDOK
	WITH DICAMBA	MARKSMAN
	WITH SIMAZIME	EKKO, ERAMOX
	WITH METALOCHLOR	PRIMEXTRA
DES-ETHYL ATRAZINE	(breakdown product of atrazine)	
DIMETHOATE		CYGON, LAGON, HOPPER STOPPER, SYS-TEM
MALTHION		MALTHION, CYTHION
CHLORFENVINPHOS		BURLANE
AZINPHOSMETHYL		GUTHION
CHLOROTHALONIL		BRAVO
CAPTAN		CAPTAN FL
PERMETHRIN		AMBUSH, POUNCE
DELTAMETHRIN		DECIS

* Additional parameters may be added to the scan as required.

4 RESULTS

4.1 Pest Control Products

A total of 98 randomly selected wells were sampled for pest control products. Test results showed that all wells were within safe drinking water limits established under the Guidelines for Canadian Drinking Water Quality (Health and Welfare Canada, 1989). Pest control products were found at very low levels in 37 of the wells, with 96% of these occurrences at concentrations less than 1 part per billion (ppb). Atrazine was the most prevalent pest control product found. For a summary of the results, see Table 2.

As also indicated by Table 2, a significant number of the detections occurred at or near the detection limit of laboratory procedures used.

4.2 Inorganic Parameters

All 234 randomly selected wells were tested for other inorganic parameters (see Table 3). With the exception of nitrate, Canadian drinking water quality guidelines for these parameters have been established on the basis of aesthetic considerations such as colour and taste. In general, the wells sampled met aesthetic objectives. The parameters which most commonly exceeded aesthetic criteria were manganese, and pH with 27 and 21 wells respectively exceeding the guideline level.

The Guidelines for Canadian Drinking Water Quality have identified 10mg/l as the maximum acceptable concentration for nitrate in drinking water, based on health considerations in infants under the age of 6 months. Twenty nine (29) of the 234 wells sampled exceeded the guideline of 10 mg/l for nitrate. This represents 12.4% of the wells sampled. Nitrate concentrations ranged from 0.26 mg/l to 46.10 mg/l. Figure 2 presents the distribution of nitrate levels found in wells of the random survey.

4.3 Bacteria

Of the 98 bacteria samples analysed, 22 had positive counts. This represents 22.4% of the wells sampled. Seven (7) samples, representing 7.1% of the total, exceeded the action limit of 10 counts/100ml, established under the Guidelines for Canadian Drinking Water Quality, with the highest count being 260 counts/100ml.

Table 2: Results of Pest Control Product Scans

Pest Control Product	Wells With Detections	Range Detected (ppb)	Median Value (ppb)	Guideline Level*1 (ppb)	Wells at or above Guideline	Detection Limit*2 (ppb)	Wells at or Near Detection Limit*3
Atrazine*4	31	0.02 – 2.19	0.12	60.0	0	0.02	10
Simazine*5	5	0.25 – 1.21	0.33	10.0	0	0.02	0
Metribuzin	4	0.004 – 0.04	0.02	80.0	0	0.004	2
Alachlor	3	0.02 – 0.06	0.06	5.0*6	0	0.01	3
Metalochlor	2	0.52 & 1.20	N.A.	50.0	0	0.02	0
Captan	1	0.01	N.A.	N.G.*7	N.A.*8	0.01	1
Chlorothalonil	1	0.065	N.A.	N.G.	N.A.	0.004	0
Dimethoate	1	0.40	N.A.	20.0	0	0.06	0

*1 Guidelines for Canadian Drinking Water Quality

*2 The average detection limit, this value varies slightly depending on operating conditions at the time of analysis.

*3 Within one order of magnitude of the average detection limit, i.e. if the detection limit was 0.02ppb, all those <0.1ppb.

*4 Includes the breakdown products Des Ethyl Atrazine and Des Isopropyl Atrazine.

*5 Includes the breakdown products Des Ethyl Simazine and Des Isopropyl Simazine.

*6 Health and Walfare Canada interim level

*7 N.G. = No guideline level is available.

*8 N.A. = Not applicable

Table 3: Results of Inorganic Screens

Parameter (reported as mg/l[*2])	Wells With Detectable Levels	Range Detected	Median Value	Guideline Level[*1]	Wells at or Above Guideline
Calcium	232	0.3 - 535.0	41.2	N.G[*3]	N.A.[*4]
Magnesium	228	0.3 - 27.4	3.1	N.G.	N.A.
Sodium	234	0.8 - 429.0	7.5	200.0	2
Chloride	173	18.6 - 455.7	28.0	250.0	4
Sulfate	232	1.3 - 1,231.0	12.5	500.0	4
Iron	119	0.03 - 1.97	0.04	0.30	6
Manganese	57	0.02 - 1.15	0.04	0.05	27
Copper	150	0.03 - 5.10	0.09	1.00	11
Zinc	197	0.02 - 1.86	0.05	5.00	0
Nitrate - N	234	0.26 - 46.10	2.68	10.00	29
Alkalinity	213	50 - 225	100	N.G.	N.A.
pH (reported to .1)	234	4.4 - 8.3	7.2	6.5 - 8.5	21
Conductivity (1.0 micro mhos)	234	45.0 - 2,570.0	292.0	N.G.	N.A.
Total Hardness (derived value)	234	1.4 - 1,376.4	122.0	N.G.[*5]	N.A.

[*1] Guidelines for Canadian Drinking Water Quality.
[*2] 1 mg/l = 1,000 ppb
[*3] N.G. = No guideline is available.
[*4] N.A. = Not applicable.
[*5] While no guideline is available for hardness, levels below 200 are acceptable, between 200 and 500 are poor but tolerable, and levels in excess of 500 are usually conssidered to be unacceptable. Only 3 wells sampled had hardness levels greater than 500.

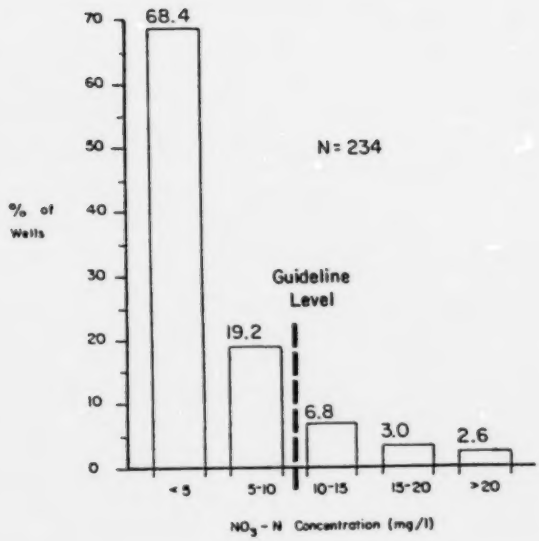

Figure 2: Distribution of NO_3-N in Sample Wells

5 DISCUSSION

5.1 Pest Control Products

As described previously, trace levels of pest control products were found in a number of wells surveyed. The product most frequently detected was Atrazine, a herbicide used primarily for weed control in corn. Atrazine has been in general use since the early 1960's, however, information from farmers indicates that it is being replaced by newer, less persistent products which fit better with modern crop rotation practices. This suggests that there may be a downward trend in the use of this product, leading to a reduction in the environmental presence of this compound.

Possible sources of pesticide residues in well water include improper storage and handling, spillage of product, equipment cleaning near wells, and movement from field applications. Devising an appropriate management and control strategy will, therefore, depend upon a determination of which factors are in fact contributing to the problem. This will be based on detailed site investigations of wells with measurable pesticide concentrations.

Data from the survey suggests that well depth may play a role in determining well sensitivity to pesticide contamination. Both the shallow and moderate depth wells appear most sensitive, while deep wells seem less sensitive. The percent of wells of each depth class, with traces of pest control products is as follows;

- 41.1% of wells less than 50 ft. deep,
- 55.5% of wells between 50 and 100 ft. deep, and
- 26.7% of wells greater than 100 ft. deep.

A similar relationship may exist between soil texture and detectable levels of pest control products, with wells in light textured soils (sands and sandy loams) more sensitive than wells in heavier textured soils (loam, clay loam and gravelly clay loam). The percent of wells in each texture class with detectable levels of pest control products being as follows;

- 40.0% of wells in sandy soils,
- 53.3% of wells in sandy loam soils, and
- 18.5% of wells in "heavier" soils (loam, clay loam and gravelly clay loam).

5.2 Nitrate

Approximately 12% of the 234 wells sampled in the survey contained concentrations in excess of the 10mg/l guideline. Comparison with historic data from across the province, which found 7% of wells sampled had levels over 10 mg/l, may indicate that wells in the study area are more sensitive to this problem that in the province as a whole.

Nitrate is a natural substance, resulting from the decomposition of organic materials in the soil. Man made sources can add to the natural background levels. Some of the sources are;

- malfunctioning septic systems,
- improper storage or handling of animal wastes, and
- excessive use of fertilizers (both chemical and organic).

It is expected that detailed site investigations to be carried out over the next two years will help establish the relative contribution made by each of these potential sources.

Well depth appears to play a role in determining the likelyhood of a well having elevated nitrate levels, with shallow wells more sensitive than deep wells. Of all the wells sampled for which depth information is available (228), the percent of wells in each depth class, exceeding the 10mg/l level is as follows;

- 14.3% of wells less than 50 feet deep,
- 10.0% of wells 50 to 100 ft. deep, and
- 3.7% of wells greater than 100 ft. deep.

The highest nitrate levels were also detected in shallow wells.

Soil texture also appears to be a factor in determining the percentage of wells exceeding the Canadian drinking water quality guideline of 10mg/l, with wells in lighter textured soils being more sensitive than those in heavier soils. The percent of wells in each texture range, exceeding the guideline is as follows;

- 13.1% of wells in sandy soils,
- 19.1% of wells in sandy loam soils, and
- 6.0% of wells in "heavier" soils (loam, clay loam and gravelly clay loam).

The data from this study suggests that wherever nitrate sources occur within areas of highly permeable soil and where shallow wells predominate, nitrate contamination is more likely.

5.3 Bacteria

Since the presence of bacteria in well water usually indicates contamination from surface water or leachate from septic fields or manure piles, all well owners with any detected coliform bacteria were informed that they should contact the local Health unit in order to have their well resampled.

6 FUTURE WORK

Phase II of this project is scheduled for completion in the spring of 1992. Further work scheduled to be carried out through the cooperative efforts of the Provincial Departments of Environment, Agriculture and Marketing, and Health and Fitness include:

1. Continuation of an ongoing quarterly survey of water quality for selected wells.
2. Detailed case studies including a survey of farming practices near the well, well inspections, and evaluation of potential contaminant sources.
3. The monitoring of long-term trends in pesticide residue levels in ground water supplies.

The purposes of this work will be threefold:

1. To document seasonal variations in contaminant levels in order that subsequent sampling to determine long term trends can be accurately interpreted.
2. To evaluate probable contributing factors to well water contamination at specific wells.
3. Development of management options to reduce or eliminate the risk of future contamination.

In addition, Environment Canada, in cooperation with Agriculture Canada will complete a detailed field study of factors influencing the migration and chemical breakdown of the pest control product Atrazine.

7 REFERENCES

Aller,L; T, Bennet; J.H. Lehr; R.J. Petty; G. Hackett, 1987 *DRASTIC: A Standardized System For Evaluating Groundwater Pollution Potential Using Hydrogeologic Settings*, National Water Well Association, Dublin, Ohio 43017, Publ. No. EPA-600/2-87-035

Health and Welfare Canada, 1989, *Guidelines for Canadian Drinking Water Quality*, Fourth edition, Federal/Provincial Subcommittee on Drinking Water of the Federal/Provincial Advisory Committee on Environmental and Occupational Health

Husch, B; C.I. Miller; T.W. Beers, 1972, *Forest Mensuration, 2nd.ed.* John Wiley and Sons, Toronto, Ont.